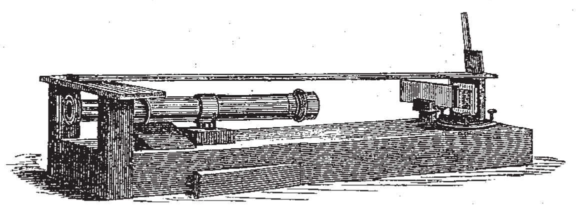
adjusted that the image of the light source is seen in the little telescope reflected by the general surface of the metal grating. Supposing a circle and micrometer attached, represented by the wooden bar at the top, the reading would now be zero.

Next, and this is the new point, a piece of glass silvered on the front surface is fixed with its surface parallel to the surface of the grating, the side of which it covers. When this is in perfect adjustment the images produced by the movable grating and the fixed mirror are superposed. Let us suppose the light source to be a Geissler tube, we get a single image of it; the fixed mirror is then very slightly inclined, so that its image lies a little above or below the one due to the grating. We now by the movable arm at top rotate the grating, the grating image vanishes from the field of view, and in a little time, if the rotation is continued, the blue of the first order spectrum makes its appearance. Each coloured image in the spectrum can in turn be brought to coincidence, with the non-dispersed image of the tube thrown by the fixed mirror, and readings of considerable accuracy can thus be obtained. The illumination of the image due to the



fixed mirror can be easily regulated by changing its position with regard to the axis of the telescope prolonged; in no case of course should any part of the ruled surface of the grating be covered. With a ring slit illuminated by the vapours of different metals, the phenomena observed are very interesting and novel; with the fixed mirror slightly inclined, the image from the fixed mirror always in the centre of the field of view forms a capital point of comparison.

More light is gained by employing an object-glass of short focus and placing the grating and fixed mirror at such a distance inside the focus that the beam falls on the ruled surface and a small fraction of the fixed mirror.

I hope the suggestion does not come too late to enable it to be utilised by the outposts during the coming eclipse. If it helps in enabling us to determine the position of the chromospheric line near H, the time I have spent on the little model will not have been thrown away. I may add that I have found that a prism of 60° dense flint placed in front of the lens of an ordinary photographic camera will give us, if properly focussed, a most useful spectrum of the eclipsed sun. J. NORMAN LOCKYER

OUR ASTRONOMICAL COLUMN

NEAREST APPROXIMATIONS OF SMALL PLANETS TO THE EARTH'S ORBIT.—Out of the 187 minor planets now known there are ten which approach the earth's orbit at their perihelia within 0·9 of her mean distance from the sun, and which may therefore afford the most advantageous opportunities for determination of the solar parallax by one or other method of observation of these bodies, already successfully applied: *Medusa* is omitted on account of uncertainty of elements. The nearest approach, 0·798, is made by *Clio*, discovered by Luther in August, 1865. *Æthra*, detected by Watson in June, 1873, makes the nearest approach to the sun 1·614; but the great depression of the planet below the plane of the ecliptic, at perihelion, prevents so near an approximation to the earth's orbit as in the case of *Clio*. The following is a tabular view of the distances in the ten cases referred to:—

	Perihelion Distance.	Heliocentric Latitude in Perihelion.	Distance from Earth's Orbit.
		° ′	
84. Clio	1·805	+ 1 57	0·798
132. Æthra	1·614	− 23 45	0·813
18. Melpomene	1·796	− 7 9	0·815
43. Ariadne	1·834	+ 0 48	0·818
12. Victoria	1·823	+ 7 40	0·828
80. Sappho	1·835	+ 5 53	0·842
8. Flora	1·856	− 5 45	0·874
33. Polyhymnia	1·890	− 0 53	0·882
42. Isis	1·890	− 6 53	0·892
50. Virginia	1·896	− 0 47	0·896

If we extended our limit to 1·0 we should include, in addition to the above, *Felicitas, Phocea, Euterpe, Thyra, Echo*, and *Feronia*.

While referring to the small planets it may be remarked that, between the perihelion of *Æthra* and the aphelion of *Hilda*, there is a difference of 2·98; and between the aphelion of *Flora* and the perihelion of *Hilda* 0·76, or upwards of three-fourths of the radius of the earth's orbit. The periods of *Flora* and *Hilda* being respectively 3·27 and 7·85 years exhibit a difference of 4·58 years. These are the extremes, as they result from the latest and most complete catalogue of elements.

According to the last Circular of the *Berliner Jahrbuch*, the following names have been proposed:—For No. 177, *Irma*, for 180, *Garumna*, and for 186, *Celuta*.

MEASURES OF DOUBLE STARS.—Many applications for copies of the earlier volumes of "the Leyton Observations" having been received after the edition had been exhausted, Mr. J. Gurney Barclay has issued a fourth volume containing the double star epochs from the commencement of observations at Leyton, with the addition of results to the end of 1877. This part includes also occultations and phenomena of Jupiter's satellites since 1865. The notes on the double-star observations comprise the principal epochs of other observers. The small companion of Procyon at a distance of about forty-five seconds, to which attention was first pointedly directed by Mr. Barclay in January, 1856, had the following position for 1863·23, angle, 294°·88, distance 45″·9, which, corrected for the proper motion of Procyon in the interval, gives for 1879·0 angle, 319°·3, distance 47″·3.

The *Astronomische Nachrichten*, Nos. 2196-99, contain measures of double-stars made by Dr. Doberck at the observatory of Col. Cooper, Markree Castle, Sligo, from the end of 1875 to the spring of 1878. The list includes most of the well-known binary systems. γ Coronæ was single in the Markree instrument in 1876-77.

Mr. Ormond Stone, Director of the Observatory at Cincinnati, writes with respect to a remark in a notice of the Cincinnati measures of double-stars, which appeared in this column, and which might be misunderstood as implying that the work carried on at the American Observatory is to a certain extent a duplication of that commenced some time since with the refractor at Melbourne. Mr. Ellery, however, has lately informed Mr. Ormond Stone that his observations are limited to stars south of 35°.

THE BINARY STAR α CENTAURI.—Mr. Maxwell Hall writes from Jamaica, on May 21, with reference to α Centauri: "Since my communication last year respecting this binary, the angle of position of the smaller star has rapidly increased at the rate of 60° per annum. I have lately taken measures in the same manner as before, few in number, but with the greatest care, so that their concordance gives them great weight."

Epoch 1878·38 Position 139°·1 Distance 2″·4

Mr. Hall adds: "There can be no doubt that the smaller star is variable: according to my estimates it has diminished during the last year; and I would therefore call attention to the subject"—and appends various estimates from $1\frac{1}{2}$ (Powell, Jacob) to 4 (Dunlop), also a table of the measured angles and distances to 1878, which it is

unnecessary to give here, as they will be accessible to most readers who interest themselves on the subject of binary stars. For the interval 1864-76, in which Mr. Hall states he had not measures in his possession, the following may be cited :—

Powell 1870·10	Position	20°·45	Distance	10″·24
Russell 1870·75	,,	22·3	,,	10·46
— 1872·47	,,	25·5	,,	9·74
Ellery 1874·15	,,	30·5	,,	8·00
Russell 1874·47	,,	30·0	,,	7·97

On the question of the brightness of the components Sir John Herschel says :—" Individually their magnitudes have been very differently estimated by other observers from what I consider to be their correct values. All agree in assigning the first magnitude to the principal star, or that which follows in R.A. (1834-37); but whereas Lacaille, and after him Fallows, Johnson, Taylor, and Messrs. Dunlop and Rumker estimate the preceding star of the fourth magnitude, I have never estimated its magnitude as seen with the equatorial lower than 2·3, and the mean of all the magnitudes assigned to it with this instrument is 1·73, or $1\frac{3}{4}$ by a mean of eleven observations. . . . . On the whole evidence afforded by my experience I am disposed to assign to it a magnitude which may be deemed indifferently either a very low first or a very high second." Sir John Herschel further considered that "it is not necessary to recur to the hypothesis of variability to account for this difference of estimation," and gave his reasons for this opinion ("Cape Observations," p. 300).

BIOLOGICAL NOTES

DECORATIVE COLOURING IN FRESHWATER FLEAS.—There is something essentially comic in the notion of a freshwater flea—a species of the entomostracous crustaceous Daphnoidæ—becoming beautifully ornamented with patches of scarlet and blue, for the purpose of seducing the affections of the opposite sex. If a scarlet coat is appreciated by the females of the very fleas of this great family to which we all belong, we ought not to be surprised at hereditary predispositions in favour of this colour, and should conclude on this ground, as on many others, that the civilian male Anthropini of western Europe have taken a foolish and unnatural step, within the last hundred years, in abandoning the use of brilliantly-coloured clothing, and giving over the exceptional advantages which it confers to soldiers and huntsmen. The figures given by Prof. August Weismann, in the *Zeitschr. wiss. Zoologie* (1878, Supplement 1), show us the water-fleas, Polyphemus and Latona, most gorgeously got up in blue and scarlet. Goethe, though he never saw them, foretold their appearance :—

" Es war enimal ein König, der hatt' einen grossen Floh,
Den liebt' er gar nicht wenig, als wie seinen eignen Sohn,
* * * * * * *
In Sammet und in Seide, war er nun angethan,
Hatte Bänder auf den Kleide, hatt' auch ein Kreuz daran,"
&c., &c.

It is to the elaborate and ingenious studies of Prof. Weismann on caterpillars—worthy to be placed by the side of the most original of Mr. Darwin's own investigations—that we owe our knowledge of an exceedingly important cause of animal coloration, namely, that which is explained by the term "startling" or "terrifying" colouration (Schreckfarben). Just as in various human races the amorous of both sexes paint their faces and adorn their bodies in order to attract one another, so nature paints by sexual selection, and just as we dress ourselves up in wigs and gowns and spectacles, or tattoo our countenances in order to terrify evil-doers so (Prof. Weismann shows) does nature paint masks with staring eyes upon the feeble caterpillar's back in order that he may enjoy the privileges so usually gained by the ass in the lion's skin. Brilliant patches of colour occur only in a few Daphnoidæ (also in a few Phyllopoda), and after a very detailed investigation as to the variations which these patches of colour present in the different species, in the two sexes, and at different seasons and at different periods of growth, Prof. Weismann comes to the conclusion that they must be regarded as a decoration acquired by sexual selection which probably was first of all confined to the male sex, but subsequently, in most cases, became transmitted also to the other sex. Probably a reciprocal and alternating sexual selection favoured this transference to the female sex, the most brilliant females being chosen by the few males existing at the commencement of a sexual period, and the most brilliant males being chosen by the relatively few females existing at the end of such a period. The existence of these "sexual periods" is a well established feature in the life-history of Entomostraca, alternating with parthenogenetic periods. From the fact that neighbouring colonies of the same species have a constantly differing arrangement of colour, it appears probable that the development of these decorative colour-patches took place after the isolation of the colonies, that is to say subsequently to the glacial period in northern Europe. The transference of the decorative coloration originally developed only by the males, took place in three directions—firstly to the other sex; secondly to the not-yet sexually mature period of growth; and thirdly to the parthenogenetically produced generations. In the various species of Daphnoidæ with decorative coloration we find different degrees of completeness of the transference in these three different directions. Only one species, viz., Latona, presents the highest degree or complete transference of the coloration to both sexes, all stages of growth and all generations of the annual cycle. Prof. Weismann concludes that the Daphnoidæ afford a further case in favour of the hypothesis that secondary sexual characters can be converted into general characteristics of the species, and that they confirm Mr. Darwin's theory of the origin of the colour-patterns of butterflies' wings.

HOW LEPIDOPTERA ESCAPE FROM THEIR COCOONS.—The mode in which butterflies and moths free themselves from their chrysalides has been a subject of some controversy, but of very little recent observation. With regard to the silkworm moth, Malpighi asserted that the animal first wets the silk with a liquid calculated to dissolve the gum that connects the threads, and then employs its lengthened head to push them aside and make an opening. Réaumur, however, maintained that the threads of silk are not merely pushed aside, but are actually severed, and believed that the eyes, which are the only hard organs of the head, are the instruments by which the threads are divided, their numerous minute facets serving the purpose of a fine file. That the threads are actually cut is the general view; and the account of the breeding of silkworms, published in the *American Philosophical Transactions*, states that cocoons, out of which the moth has escaped, cannot be wound. On the other hand it is known to be a common practice with many moths the chrysalis of which is very hard, to discharge, immediately before issuing forth, a copious fluid from the mouth by which the shell is so softened that they are able to force their way through it. In an article in the *American Naturalist* for June, Dr. A. S. Packard, after reviewing our previous knowledge of the subject, gives an account of some interesting observations of his own. His attention being arrested by a rustling, cutting, and tearing sound, issuing from a cocoon of the large green swallow-tail silkworm moth, *Actias luna*, he discovered, on examination, a sharp black point moving to and fro, and then another, until both points had cut a rough irregular slit, through which the shoulders of the moth could be seen vigorously moving from side to side. The hole or slit was made in one or two minutes, and the